

# Sources, data and methods of WMEAT 2012

*This section describes the sources and characteristics of data used in this edition of WMEAT, the methods by which those data are used to produce numeric values, and the rationales for those methods. Readers should note that **WMEAT figures, especially for armed forces personnel, military expenditures and arms transfers, are neither so accurate nor so reliable as uniform presentation in statistical tables might seem to imply**, due to incompleteness, ambiguity, or total absence of data for some countries either in those parameters or in parameters, such as GDP price deflators or exchange rates, used in Table I to covert local-currency-denominated values to U.S. dollars.*

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## Time period covered

With this edition, *World Military Expenditures and Arms Transfers* (WMEAT) reverts to its former practice of titling its editions by year of preparation rather than most recent year covered. *WMEAT 2012* presents annual data for the 11-year period 1999 – 2009.<sup>1</sup> [WMEAT 2005](#), covering 1995-2005 and published in 2011, was the most recent previous edition. We hope to publish an edition of WMEAT annually, with a three-year lag between most recent year covered and year of publication, since comprehensive final data are generally unavailable, even for non-military parameters, until two years later.

## New features in this edition

*WMEAT 2012* completes the transition, begun in *WMEAT 2005*, to statistical presentation in spreadsheet format. Other new features include:

- presentation of values converted to dollars from other currencies at multiple conversion rates, rather than at only one conversion rate;
- political groupings of countries in the form of quintiles of world population ranked by NGO-assessed national degree of political democracy;
- economic groupings of countries in the form of quintiles of world population ranked by national GDP per capita;
- basing rankings on 11-year mean values rather on values for the most recent year covered;
- rankings, in parameters measured by WMEAT, not just of geographic, political and economic groups, but also of individual countries;
- presentation of labor force size as a demographic comparator to the number of armed forces personnel;
- presentation of country values compared with world values (rows 99 through 146 of each country page);
- estimation, based on World Trade Organization (WTO) merchandise trade data, of total goods and services trade for countries and years for which the World Bank provides no such data;
- omission (from Table I) of central government expenditures (CGE) as a comparison parameter for military expenditures;<sup>2</sup>

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<sup>1</sup> Most reported data are for calendar years. For some countries, however, some source data are available only for fiscal years that diverge from calendar years. In such cases, the fiscal year which contains the most months of a given calendar year is assigned to that year; *e.g.*, source data for the fiscal year April 2002 through March 2003 would be shown under 2002 in WMEAT tables. Source data for fiscal years ending on June 30 are normally entered under the calendar year in which they end.

<sup>2</sup> The magnitude of CGE relative to GDP varies substantially across countries with comparable GDP, due to differences not only in the extent to which such services as higher education, health care, and retirement pensions are provided by government, but also in the extent to which government is federally decentralized. Cross-country comparisons of military spending as a share of CGE can be misleading unless informed by awareness both of cross-country differences in CGE as a share of GDP and of the reasons for such differences.

- omission (from Table IV) of values of arms transfers contracted or authorized as distinct from deliveries;
- replacement of the “Highlights and Trends” section with a shorter “Introduction and Overview,” data about trends and now being presented in the spreadsheet workbooks; and
- changing the name of this section from “Statistical Notes” to “Sources, data and methods.”

These new features are intended to render WMEAT more accurately descriptive and useful to diverse readers.

### Scope of coverage

The statistical tables in *WMEAT 2012* report 1999-2009 data for 170 countries (as of 2009), including the preponderance of the 192 [members of the United Nations](#) as of 2009, as well as China-Taiwan.<sup>3</sup> In 2009, these 170 countries accounted for 99.7% of the global population of 6.76 billion (as estimated by the U.N. Statistics Division) and 99.7% of the global GDP of \$58.09.1 trillion (as estimated by the World Bank).<sup>4</sup> U.N. members not covered are generally small and not militarily significant; relevant source data for them are often unavailable.<sup>5</sup> Sub-national groups and non-state entities are not covered with respect to any parameter, including military expenditures and arms transfers.

In Table I (military expenditures), the term “*world*” refers to the sum of the countries covered. In Tables II, III and IV (arms transfers), the term “world” refers to all trade both to and from identifiable specific countries covered by WMEAT. All other trades, which cannot be disaggregated by both exporter and importer across countries covered by WMEAT, are placed in the “other” entry. The growth of “other” arms transfers relative to “world” arms transfers in recent years is due chiefly to increasing U.S. commercial arms exports to destinations identified only as “various” by the licensing agency, the Directorate of Defense Trade Controls (DDTC).<sup>6</sup>

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<sup>3</sup> Hong Kong and Macau are treated as part of “China, mainland.” The presence of “China, Taiwan,” in WMEAT country tables is not intended to imply that Taiwan is a country distinct from China.

<sup>4</sup> Sources of estimates: The World Bank Group’s *World Development Indicators* (WDI) database. All WDI data used in preparing WMEAT 2012 are from the [WDI database](#) posted online on 15 December 2011.

<sup>5</sup> The UN member countries as of 2009 that are not covered by WMEAT are: Andorra, Antigua and Barbuda, the Bahamas, Comoros, Dominica, Grenada, Liechtenstein, Maldives, Marshall Islands, Micronesia, Monaco, Palau, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Samoa, San Marino, Seychelles, Solomon Islands, Tuvalu, Vanuatu, and Western Samoa. Also omitted or not entered as distinct entities are: non-member countries Kiribati, Nauru, Tonga, and The Holy See; the territory with unresolved sovereignty of Western Sahara; the [dependencies and areas of special sovereignty](#) of Bermuda, Hong Kong, Macau, Puerto Rico, and many others, mainly very small islands.

<sup>6</sup> WMEAT’s “other” arms transfers as are overwhelmingly U.S. commercial arms exports. Destinations of such exports licensed by DDTC are reported by DDTC in its annual “[Section 655](#)” reports. .

## Country groupings

This edition of WMEAT groups countries into ***geographic, political and economic groups*** for purposes of statistical analyses.

In every edition of WMEAT, countries have been assigned to ***geographic groups***. However, since *WMEAT 2005*, WMEAT has assigned European countries to either of two groups that are not strictly regional, namely the ***European Union*** and ***Non-E.U. Europe***. In *WMEAT 2012*, this is done on the basis of [E.U. membership](#) as of the end of 2009. In *WMEAT 2012*, the geographic group to which each country is assigned is indicated both on the Table of Contents page and at the top of each country page in Table I (the military expenditures table), as well in Table III (the arms transfers table). The geographic groupings of countries in *WMEAT 2012* differ from those in *WMEAT 2005* only in that countries joining the European Union between the end of 2005 and the end of 2009 (Bulgaria and Romania) are shifted from the Non-E.U. Europe group to the European Union group.

This edition revives WMEAT's practice of assigning countries to ***political groups***, which were absent from *WMEAT 2005* due to the obsolescence of the political groupings used in previous editions (e.g., "former Warsaw Pact" and "OPEC"). The political groups used in *WMEAT 2012* are ***quintiles of world population ranked by NGO-assessed country political scores***. The two sets of NGO country scores used for this purpose are: (1) the "[political rights](#)" (PR) scores assigned to countries by Freedom House (FH) in the course of producing its annual *Freedom in the World* report (although published separately from that report), which range from 0 (worst) to 40 (best), a 40-point scale; and (2) the "[voice and accountability](#)" (V&A) scores assigned annually to countries by The World Bank Institute (WBI), which range in practice from about -2.30 to about +2.00, a 430-point scale.<sup>7</sup> All such scores assigned to a country during the period covered are recorded on the country page of Table I (rows 75 and 76). FH:PR and WBI:V&A country rankings regress on each other with a slope of about one, a high correlation and a low standard error; they may be interpreted as two measurements of roughly the same thing, perhaps most simply described as the extent to which a country's political structure is democratic.<sup>8</sup> To create an 11-year-mean political ranking for countries, WMEAT makes separate 11-year FH:PR and WBI:V&A country rankings

<sup>7</sup> Political scores assigned to countries by these NGOs have been used for purposes of determining country eligibility for Millennium Challenge assistance, consistent with section 607 of the Millennium Challenge Act of 2003 (MCA), title VI of Division D of [PL 108-199](#), the Consolidated Appropriations Act, 2004 [118 Stat. 215], enacted Jan. 23, 2004, as amended, codified as 22 USC 770, which requires use of "objective and quantifiable indicators of a country's commitment to ... just and democratic government."

<sup>8</sup> FH's PR scores are only half of the basis for its overall *Freedom in the World* country rankings; the other half is "civil liberties" scores. – Article IV, Section 10, of the IBRD's Articles of Agreement, a prohibition on political activity, has been so interpreted by World Bank General Counsel as to lead the Bank to avoid using the word "democracy," and to prefer instead terms like "voice and accountability in governance." See, for example, Ibrahim F.I. Shihata, "[Prohibition of Political Activities in the Bank's Work](#)," Legal Opinion by the Senior Vice President & General Counsel," July 12, 1995.

based on average country scores during the 11 years covered, then averages the 11-year-mean FH:PR and WBI:V&A rankings, weighting each by the number of annual observations available.<sup>9</sup>

This edition also introduces new *economic groups*. *WMEAT 2005* used the World Bank's [country classification](#) based on per capita income: high-income countries, divided into [OECD members](#) and non-OECD countries; upper-middle income countries; lower-middle income countries; and low-income countries. However, the World Bank's per capita income groups are not equal with respect either to the number of people or to the amount of income included.<sup>10</sup>

In *WMEAT 2012*, the economic groups of countries are *quintiles of world population ranked by national gross domestic product (GDP) per capita*, sourced from the World Bank's [WDI database](#). Two sets of such quintiles are offered. One, indicated by headings in **green** typeface, is based on GDP converted to U.S. dollars at a real market exchange rate (**MER**), based on the mean of all 11 year-average market exchange rates, assigned to the mid-period (sixth) year.<sup>11</sup> The other, indicated by headings in **dark red** typeface, is based on GDP converted to U.S. dollars at purchasing power parity (**PPP**).<sup>12</sup> The quintile of world population to which a country is assigned may vary depending on which conversion method is used.

Among the advantages of using world population quintiles for political and economic groups is that all such groups contain the same number of people. This facilitates comparison among groups and obviates conversion of group values to per capita values. As with any country groupings, the group positioning of such demographic and economic behemoths as China, India and the USA greatly influences the relative values of the groups in many parameters.

In *WMEAT 2012*, as in previous editions of *WMEAT*, a country-group's exports and imports, both of arms and of all goods (and, since *WMEAT 2005*, of all services), includes trade between states within a geographic, economic or political group; *i.e.*, trade values of groups of countries are "gross" rather than "net" of intra-group trade.

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<sup>9</sup> The way in which *WMEAT* combines FH:PR and WBI:V&A results is entirely ordinal, not cardinal. A country's FH:PR or WBI:B&A ranking is its score-ordered position in a roster of *WMEAT*-covered countries. Given that *WMEAT* now covers 170 countries, the range is 1 to 170 for both FH:PR and WBI:V&A. Alphabetical ordering of country names is used to break ties.

<sup>10</sup> Although widely used for analytic purposes, these country groupings are designed not for such purposes, but to determine the eligibility of countries for various kinds of preferential lending by the institutions of The World Bank Group.

<sup>11</sup> That is, it is based on GDP converted to U.S. dollars using currency conversion **Method 3**, described below in the subsection titled, "Methods of converting military expenditures and GDP to U.S. dollars."

<sup>12</sup> That is, it is based on GDP converted to U.S. dollars using currency conversion **Method 4**, described below in the subsection titled, "Methods of converting military expenditures and GDP to U.S. dollars."



- For example: an export from France to Belgium is counted both as an E.U. export and as an E.U. import; an export from the U.S. to the U.K. is counted both as an export and as an import of the group of countries that make up the richest quintile of world population, based on national GDP per capita; and an export from the U.S. to the U.K. is counted both as an export and as an import of the group of countries that make up the most democratically governed quintile of world population.
- For most groups, goods and services trade net of intra-group trade cannot readily be evaluated, because no adequate worldwide data for trade in all goods and services, disaggregated by country of destination and well as country of origin, are readily available; WMEAT presents regional arms trade data in “gross” form comparable with that of regional total trade data.
- The proportion by which a group’s “gross” trade exceeds its trade net of intra-group trade tends to increase with the number of states in the group; *e.g.*, it is likely to be greater for the E.U. than for North America. It also tends to be greater for richer groups than for poorer groups, *i.e.*, it is likely to be greater for Europe than for Africa. However, a group’s trade balance (surplus or deficit), either for the arms trade or for trade in all goods and services, is the same whether calculated “gross” or net of intra-regional trade.

### Parameters covered: definitions and data sources

Table I reports figures in two military parameters – *armed forces* and *military expenditures*. It also reports *population* and *labor force* as comparators to the number of armed forces personnel and *gross domestic product (GDP)* as a comparator to military expenditures. The figures are expressed in three ways:

- as numbers of people for the *demographic* parameters of *armed forces*, *population* and *labor force*.
- as monetary values expressed in U.S. dollar terms for the *economic* parameters, *military expenditures* and *GDP*, although these values are usually expressed in local currency terms by WMEAT’s data sources; and
- in percentage terms for various ratios of the military and comparator figures.

Tables II, III and IV report figures in one military parameter, *arms transfers* delivered, including arms exports, arms imports and arms trade balance. Table II also reports *total trade in goods and services*, including total goods and services exports and imports and the balance of total trade in goods and services, as a comparator to arms transfers. Both arms transfers and total trade in goods and services are reported not only by WMEAT but also by WMEAT’s data sources in U.S. dollar terms. In addition:

- Table II reports ratios between arms transfers and total trade in percentage terms;
- Sub-table II.f reports the ratio of the value of a country’s arms exports to the values of its arms imports in numerical terms; and
- Sub-table IV.c report arms transfers as percentages of the world arms trade.

### Armed Forces

Armed forces figures, given in Table I, enumerate active-duty military personnel. Reserve forces are included only insofar as activated.

Figures for all [NATO member countries](#) including the *United States* are as reported on the [Defense Expenditures](#) page of the NATO website.<sup>13</sup> Although *Iceland* has paramilitary forces, WMEAT reports it as having no armed forces or military expenditures because NATO reports it as having none.<sup>14</sup>

Estimates of the number of armed forces personnel for non-NATO countries are based on a variety of US Government and other sources, including the IISS's [Military Balance](#) and [Jane's World Armies](#), *Jane's World Navies*, *Jane's World Air Forces* and *Jane's Defense Budgets*. WMEAT now seeks to report the number of active-duty armed forces members on payroll, not the (often higher) number authorized by law or the number physically present or effective (often lower due to corruption or chronic disease). Whether paramilitary forces are included is guided by NATO accounting practice; it depends on the extent to which such forces resemble regular military forces in their organization, equipment, training, and mission.<sup>15</sup>

### Population

Whereas previous editions of WMEAT sourced population figures from the [International Database](#) (IDB) of the U.S. Bureau of the Census, *WMEAT 2012* uses the

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<sup>13</sup> In 2004, NATO members agreed to change NATO's definitions of defense personnel and expenditures to exclude paramilitary forces that cannot realistically be deployed for military missions and expenditures for such forces. Although releases accessible via the ["Information on Defence Expenditures"](#) page of NATO's website claim that NATO data present new-definition figures for defense personnel back through 2003 and for defense expenditures back through 2002, data for the first years covered by this report are not definition-revised for any NATO member country, and data discontinuities seem to occur as late as 2009. The data discontinuities resulting from application of the new definitions are large for some countries, *e.g.*, a fall in Turkish defense personnel from 816 to 534 thousand in one year. Consequently, figures in Table 1 of this report overstate the decline or overstate the increase, over the period covered, in the number of armed forces personnel and in the military expenditures of some NATO member states, and hence also for the world, for the E.U., and for the richest and most democratic quintiles of world population.

<sup>14</sup> By contrast, WMEAT counts as armed forces paramilitary forces of non-NATO countries, namely Costa Rica, Haiti, and Panama, that have no other armed forces; WMEAT also counts outlays for these forces as military expenditures.

<sup>15</sup> In applying to non-NATO countries NATO criteria for including paramilitary forces and related expenditures in armed forces and military expenditures, this edition of WMEAT is guided in part by a country's political rankings, which, along with information about organization, recruitment, equipment, training and deployment of the armed forces, may indicate the extent to which the mission of the military appears to be internal security rather than external defense.

population data provided by the World Bank's [WDI database](#), which derive from the U.N. Population Division (UNPD), and ultimately from U.N. member state reporting.<sup>16</sup> The UNPD data are provided by the World Bank in spreadsheet form.

### *Labor force*

WMEAT 2012 presents labor force data in Table I, both on each country page (rows 83 and 84) and on the second "Geographic groups" world page. This is the first edition of WMEAT to present labor force data. It does so for several reasons:

- For many purposes, including assessing the labor-intensivity of the armed forces relative to the labor-intensivity of the economy as a whole, labor force size is a better demographic comparator to armed forces personnel than is population.<sup>17</sup>
- Labor force size varies greatly as a share of population across countries.
- Labor force as a share of population is changing in novel ways in many countries, due chiefly to unprecedented fertility rate declines and resulting changes in population age structures.

For most countries, the labor force data are taken from the World Bank's [WDI database](#). For countries for which the World Bank offers no labor force data, WMEAT either obtains such data from national government statistical publications or estimates labor force size based on population and on (a) the population age structure and (b) the apparent extent of female participation in the market economy. These two factors chiefly determine the magnitude of the labor force as a share of population.

### *Military Expenditures*

Insofar as possible, WMEAT reports military expenditures on the basis of actual outlays or disbursements, in contrast to proposed or approved budgetary allocations or "obligational authority," although source data of the latter types may be taken into account if disbursements-basis expenditure data are unavailable.

Insofar as possible given data quality constraints, WMEAT reporting of military expenditures now attempts to follow the NATO definition. In this definition, (a) civilian-type expenditures of the defense ministry are excluded and military-type expenditures of other ministries are included; (b) grant military assistance is included in the expenditures

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<sup>16</sup> However, this edition of WMEAT estimates the population of Burma (Myanmar) as being substantially less than reported by UNPD, and its labor force as being substantially less than reported by the World Bank, for reasons stated in American Embassy Rangoon's 1997 [Foreign Economic Trends: Burma](#) report, page 99 (note 51).

<sup>17</sup> This assessment not only is interesting in itself, but also is part of this edition of WMEAT's effort to estimate, albeit notionally, a defense-sector-specific PPP rate, used in currency conversion [Method 5](#), described below in the subsection titled, "Methods of converting military expenditures and GDP to U.S. dollars."



of the donor country; and (c) purchases of military equipment on credit are included at the time the debt is incurred, not at the time of payment.<sup>18</sup> Nevertheless, for many non-NATO countries, WMEAT values are based chiefly on the reported expenditures of the ministry of defense. For [NATO member countries](#), WMEAT reports their [Defense Expenditures](#) as recorded on the NATO website.<sup>19</sup>

Whether this edition of WMEAT includes, in a non-NATO country's military expenditures, its expenditures for paramilitary forces specifically designed chiefly for internal security functions (*e.g.*, for a gendarmerie), depends in part on the extent to which the mission of the military is internal security rather than external defense.<sup>20</sup>

A wide variety of data sources is used for non-NATO countries including: national sources; the publications and data resources of US government agencies; standardized but voluntary annual national reporting to the UN via its [Instrument for Reporting Military Expenditures](#); standardized annual "Vienna Document" reporting to the Forum for Security Cooperation (FSC) of the [Organization for Security and Co-operation in Europe](#) (OSCE) by OSCE member states (obligatory but not publicly available); and other international sources.

In Table I, *the military expenditure values are of uneven accuracy and completeness*. For example, there are indications or reasons to believe that the military expenditures reported by some countries consist mainly or entirely of recurring or operating expenditures and omit all or most capital expenditures, including arms purchases. In some of these cases, estimating military expenditures, consistent with the NATO definition, involves adding to a country's other military expenditures some of the value of arms imports (as shown in Table II and converted to national currency by current exchange rates). However, as previously noted,<sup>21</sup> the proportion of the value of arms imports that should be added depends on the "grant element" proportion of the arms transfer financing, which commonly is not readily observable.

WMEAT's estimates of military expenditures generally exclude those of armed groups distinct from any sovereign national government, *e.g.*, Hezbollah in Lebanon, the Rally for Congolese Democracy in the Democratic Republic of Congo, and the Lord's Resistance Army in Uganda.

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<sup>18</sup> To operationalize the NATO definition of military expenditures meaningfully would require detailed knowledge of the financing terms of arms transfers. The value of an arms transfer should be credited to the military expenditures of the exporting country rather than the importing country insofar as it is grant financed. However, arms transfers are often financed both preferentially and opaquely, and the "grant element" percentage of a preferential loan depends on characteristics, like grace periods and contract interest rates relative to default-risk-adjusted market interest rates, that frequently are not readily observable in the arms trade.

<sup>19</sup> See notes 13 and 14, above.

<sup>20</sup> See note 15, above.

<sup>21</sup> See note 18, above.

For countries that may have major clandestine military weapons development programs, such as **Iran**, estimation of military expenditures is extremely difficult and especially subject to errors of underestimation.

Government practices that commonly obscure the magnitude of such expenditures include double-bookkeeping, use of extra-budgetary accounts, highly aggregated budget categories, opacity of military assistance or of arms transfer financing, repression or manipulation of foreign exchange markets, and use of inoperative exchange rates for national accounting. In some cases these practices appear intended to obscure the magnitude of military spending; in other cases, they merely have that effect. Although all governments have incentives to conceal some military spending from potential foes, the more repressive of them may also have strong incentives to conceal much military spending from their own citizens, external creditors, and consumers of their exports. Casual observation suggests a broad and strong correlation across countries and over time between democratic accountability in governance and transparency of military expenditure. WMEAT's military expenditures estimates generally are more reliable for more developed countries with democratic governments.

Evaluating the military expenditures of some countries, such as **North Korea**, is made difficult by the exceptional scarcity and ambiguity of released information. In such cases, WMEAT estimates are labeled with an [indicator of extraordinary uncertainty](#). In this edition, WMEAT's estimates of North Korean military spending rely in part on the results of studies by the Korea Institute for Defense Analyses, a South Korean government think tank specializing in North Korean military affairs.

For **Russia** and **China**, all known estimates of military spending remain rough. WMEAT's estimates of Russian and Chinese military spending (like those from other sources) should be treated as having a wide margin of error.

Other published sources used to evaluate military spending include national government websites and publications, the [Government Finance Statistics](#) issued by the International Monetary Fund (IMF/GFS); the [SIPRI Yearbook: World Armaments and Disarmament](#), issued annually by the Stockholm International Peace Research Institute; and [The Military Balance](#), issued annually by the International Institute for Strategic Studies (IISS, in London), and [Jane's Defence Budgets](#).

### *Gross Domestic Product (GDP)*

GDP measures the final value of market-traded goods and services produced within the territory of a country, regardless of the nationality of the firms or individuals engaged in their production. The source of GDP data for most countries is the World Bank's [WDI database](#), which provides GDP estimates in both current and constant national currency terms.

For countries that are not members of the World Bank or have not reported GDP data to the World Bank, GDP values (sometimes in dollar terms) are sourced from sources including the [National Accounts Main Aggregates Database](#) of the U.N. Statistics Division and the [EIU Websites Data Services Alacra](#) of the *Economist Intelligence Unit (EIU)*.

### *Arms Transfers*

Arms transfers (arms imports and exports), represent the international transfer (under terms of grant, credit, barter or cash) of military equipment and related services, including weapons of war, parts thereof, ammunition, support equipment, and other commodities designed for military use, as well as related services. Among the items included are tactical guided missiles and rockets, military aircraft, naval vessels, armored and non-armored military vehicles, communications and electronic equipment, artillery, infantry weapons, small arms, ammunition, other ordnance, parachutes, and uniforms. Dual use equipment, which can have application in both military and civilian sectors, is included when its primary mission is identified as military. The building of defense production facilities and licensing fees paid as royalties for the production of military equipment, as well as equipment delivery, maintenance, operating and training services, are included when they are contained in military transfer agreements. Military services such as training, supply, operations, equipment maintenance or repair, technical assistance, and construction are included where data are available.<sup>22</sup> Excluded are foodstuffs, medical equipment, petroleum products and other supplies.

The arms imports and exports statistics contained in Tables II, III and IV are estimates of the value of goods actually delivered during the reference year(s), in contrast both to payments and to the value of programs, agreements, contracts or orders concluded during the reference year(s). Deliveries data represent arms transfers only to governments or to entities (typically enterprises) authorized by their countries' governments to receive them.

***U.S. arms exports*** in WMEAT accounts include private (commercial) enterprise-to-government or enterprise-to-enterprise arms exports under the Direct Commercial Sales (DCS) program administered by the [Directorate of Defense Trade Controls](#) (DDTC) in the Bureau of Political-Military Affairs of the U.S. Department of State, pursuant to section 38 of the Arms Export Control Act, as amended (codified as [22 USC 2778](#)) as well as government-to-government transfers under programs administered by the Department of Defense (DOD) including: Foreign Military Sales (FMS) including Foreign Military Construction Sales (FMCS), Drawdowns of non-excess DoD equipment stocks (Drawdowns); transfers of Excess Defense Articles (EDA); the Military

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<sup>22</sup> Services appear to constitute a recently growing and now double-digit albeit uncertain minority percentage of the total value of global arms transfers. The services component of arms transfers seems particularly large in conjunction with transfers of technically sophisticated and complex equipment, especially to less developed countries.

Assistance Program (MAP), and International Military Education and Training (IMET), all administered by DoD's [Defense Security Cooperation Agency](#) (DSCA); and Ship Transfers, administered by the U.S. Navy through its Program Executive Office, Ships (PEOS), the [Security Assistance Directorate](#) of its International Programs Office (IPO), and the Ship Transfer Program Office of its [Naval Sea Systems Command](#) (NAVSEA).

For years since 1996, principal sources for the value of U.S. arms exports, by year and country of destination, include three distinct annual publications, all published pursuant to Section 655 of the Foreign Assistance Act, as amended (in 1996), codified at [22 USC 2415](#):

- DDTC's "Section 655 Report," published on the [reports](#) page of DDTC's website. These reports, prior to that for FY 2008, provide the value only of arms exports licensed by DDTC, which WMEAT adds into its values for U.S. arms export "agreements" in Table IV; the report for FY 2008 also provides the value of shipments (deliveries) of arms exports under the DCS program.
- The Department of State's annual [Congressional Budget Justification for Foreign Operations](#) (CBJFO), typically in "Supporting Information" included in or appended to Part III, has provided, for years prior to 2007, the value of shipments (deliveries) under DDTC's DCS program.
- The *DSCA Facts Book*, also known as the *DSCA Historical Factsbook*, published by DoD/DSCA, of which the most recent edition has been accessible on the [publications](#) page of DSCA's website, and of which editions for past years have been made publicly available by the Arms Sales Monitoring Project of the Federation of American Scientists (FAS/ASMP), on the "[U.S. Arms Transfers: Government Data](#)" page of the FAS website. The *DSCA Facts Book* has provided deliveries data for exports under FMS and FMCS, EDA under MAP, other MAP including MAP drawdowns, and IMET. DSCA has stated in the notes to FactBooks that DoD considers IMET fully delivered when it is funded.

In addition, FAS/ASMP has published annually, on the "[U.S. Arms Transfers: Government Data](#)" page of the FAS website, portions of DoD/DSCA's "Section 655 Report" that include an informative accounting of authorizations of Drawdowns and EDA but have not been published elsewhere. This edition of WMEAT estimates deliveries of EDA as equal to EDA authorizations and deliveries of Drawdowns as equal to the average of the previous three years' Drawdowns authorizations.

Data for the value of U.S. ship transfer agreements and deliveries, not known to be published, are obtained from NAVSEA's Ship Transfer Program Office.

The terms on which the non-services components of U.S. arms exports are valued (*e.g.*, FAS, FOB or CIF) are not known to be consistent across the above-listed programs.

In this edition of WMEAT, as in *WMEAT 2005*, values for U.S. arms exports are for fiscal years as reported by the Department of State or of Defense as described above, with the following provisos:

- WMEAT's (unpublished) estimates of deliveries under the DCS program, added into WMEAT's published estimates of U.S. arms export deliveries, include

shipments under the DCS program permitted by exemptions rather than by licenses.

- *WMEAT 2012* continues the method of U.S. arms export estimation first applied by *WMEAT 2005*, which substantially revised, upward, WMEAT's estimates of the values of total U.S. arms export deliveries and hence of world arms transfers delivered. This reflects a large increase in the aggregate value of U.S. arms export deliveries reported by the above-referenced sources for 2005 - 2008 relative to previous and subsequent years; that increase derives from a change in data collection method. Estimates of the values of U.S. arms export deliveries for 1999 through 2004 and for 2009 involve upward revision of the aggregate of the arms export values reported by the above-referenced sources for those years, so as to render them consistent with WMEAT's estimate of the value of U.S. arms export deliveries for 2005 - 2008.

WMEAT's values of U.S. arms exports substantially exceed those found in some other published sources because they do not exclude commercial arms exports licensed by DDTC, which appear to account for a large and growing share of U.S. arms exports.

*U.S. arms imports* in WMEAT accounts include (a) imports of military-type goods, data for which are obtained from the Foreign Trade Division of the Census Bureau of the Department of Commerce (Census/FTD), and (b) Department of Defense direct expenditures abroad for major equipment, data for which are obtained from the Balance of Payments Division of the Commerce Department's Bureau of Economic Analysis, which compiles such data from DOD sources.

The goods in (a) are those in Census FTD's "Import End Use Categories 50000 and 50010," and include: complete military aircraft and parts; engines and turbines for military aircraft; military trucks, armored vehicles, *etc.*; military (naval) ships and boats; tanks, artillery, missiles, guns, and ammunition; military apparel and footwear; and other military goods, equipment and parts. Data for such U.S. military imports for the five most recent years and for specific countries of origin have been publicly accessible on the "[U.S. Imports by 5-digit End Use Code](#)" page of the website of the Census Bureau. These import End Use Category data are in terms of customs value for general imports.

WMEAT's values for *arms imports and exports for countries other than the United States* are estimates by U.S. Government sources, provided in current U.S. dollar terms. The merchandise components of these data are understood generally to be valued in FAS rather than CIF terms.

Information on arms transfers comes from a variety of sources and is sometimes acquired and processed with a considerable time lag.

Close comparisons between the estimated values shown for arms transfers and for military expenditures are not warranted. Frequently weapons prices do not reflect true production costs. Furthermore, much of the international arms trade involves offset or discounted prices, full-grant financing, highly preferential debt financing, barter



arrangements or third party payments, or partial debt forgiveness. Acquisition of armaments thus need not impose the burden on an economy, whether in the same year or in other years, that is implied by the estimated U.S. dollar value of the shipment. Therefore, the value of arms imports should be compared to other categories of data with care.

### *Total Imports and Exports*

In this edition of WMEAT, as in *WMEAT 2005*, the values for total imports and exports, found in Table II, include not only merchandise but all goods and services, in order to render “total imports” more comparable with “arms transfers,” which appear increasingly to consist of services as well as goods. For most countries, the values for imports and exports of goods and services, by country and year, are sourced from the World Bank’s [WDI database](#), which provides them in current U.S. dollar terms. The merchandise trade component is understood to be calculated in CIF terms for imports and in FAS terms for exports.

The World Bank provides no data for goods and services imports or exports for some years for some countries.<sup>23</sup> In *WMEAT 2012*, for the first time, total goods and service imports or exports for countries and years for which the World Bank provides no data are estimated based on merchandise trade values published online by other sources, chiefly the World Trade Organization (WTO). [WTO merchandise trade values](#) are multiplied by the global ratio of total goods and services trade to merchandise trade for the year. For countries for which no WTO merchandise trade data are available,<sup>24</sup> merchandise trade estimates from other sources, such as national statistical publications or the CIA’s [World Factbook](#), are used in the same way.

### **Rounding and significant digits**

In Table I, armed forces personnel are expressed in thousands of persons, population and labor force in million of persons, and military expenditures and GDP in millions of U.S. dollars. Values are rounded at least to these units, and are further rounded if necessary to show only three significant digits. Ratios and percentages vary in their rounding, depending in part on their typical magnitude, and in part on whether they are given for single countries (sometimes more rounded) or for groups of countries (sometimes less rounded), but all are rounded to show no more than three significant digits.

<sup>23</sup> In *WMEAT 2012*, for at least some years covered, Afghanistan, Algeria, Bhutan, Bosnia and Herzegovina, Brunei, Burkina Faso, Chad, China (Taiwan), Congo (Republic of), Congo (Dem. Republic of), Cuba, Equatorial Guinea, Eritrea, Gabon, Gambia, Georgia, Greece, Guinea, Guinea-Bissau, Iran, Iraq, Korea (North), Kosovo, Lebanon, Liberia, Luxembourg, Macedonia, Madagascar, Malawi, Mauritania, Montenegro, Qatar, Sao Tome and Principe, Serbia, Slovakia, Somalia, Tajikistan, Timor L’Este, Turkmenistan, United Arab Emirates, Uzbekistan, Vietnam, Zambia, and Zimbabwe.

<sup>24</sup> In *WMEAT 2012*, for at least some years covered, China (Taiwan), Kosovo, Luxembourg and Somalia.

It is hoped that rounding to no more than three significant digits may remind users of the imprecision of most values, ratios and percentages in Table I, although it may tend to overstate that imprecision for some parameters and fields (*e.g.*, U.S. armed forces personnel) while understating it for others (*e.g.*, the military expenditures of Bhutan). Of course, systematic rounding to no more than three significant digits makes the magnitude of rounding increase with the magnitude of values rounded.

In Table I, rounding and number of significant digits shown does not vary across counties, groups of countries, or years, or across editions of WMEAT, to reflect varying confidence in values shown. Such variation is not feasible given limits on resources available for WMEAT production, and resulting error seems likely to be small relative to error from other sources.

In Table I, rounding of all values, percentages and ratios is done only after all calculation. To vary the number of significant digits to reflect varying confidence in the precision of country-specific and year-specific values before calculation of eleven-year means, country-group totals, and diverse percentages and ratios, is not feasible given limits on resources available for WMEAT production. Furthermore, the resulting error seems likely to be small relative to error from other sources.

In the arms transfer tables (Tables II, II and IV), all trade values for both total trade and arms trade and for both specific countries and groups of countries are rounded to the nearest tenth of a billion (100 million) U.S. dollars. Ratios of arms exports to arms imports are rounded to thousandths. Percentages are rounded to tenths of a percent, except that in Table IV.c, suppliers' market shares are rounded to percents for markets smaller than the global market. This rounding of arms trade values, like other aspects of the structure of the arms trade tables, is a condition of WMEAT's use of some of its arms trade input data; total trade data are rounded identically. No further rounding to limit the number of significant digits is attempted, partly because WMEAT is unable to assess the relative precision of arms trade values across countries or years. As in Table I, rounding of all values, percentages and ratios is done only after all calculation.

### Indicators of extraordinary uncertainty in Table I

On the country pages of Table I, annual figures are color-coded to indicate levels of uncertainty. Rough estimates that seem uncommonly uncertain are shown in **green** typeface. Very rough estimates that seem still more uncertain, being based on scant information and apparently subject to a wide range of error, are shown in **blue** typeface. The symbol "**N/A**," appearing in **red** typeface instead of a value or estimate, indicates an estimate so egregiously uncertain that it seems not to warrant publication.

However, whether a highly uncertain estimate warrants publication, that is, whether it is shown in **blue** typeface or as a red "**N/A**," may depend not only on perceived uncertainty (an information-quality consideration), but also upon international military importance (an information-demand consideration). For example, the quality of

military spending and GDP data for North Korea is so poor that if its military were not widely perceived as threatening other countries, estimates of its GDP and military expenditures might be assigned an “N/A” (as military expenditures for *Bhutan* are) rather than shown in blue.

An estimate is made of every variable covered for every country covered in every year covered, even if an “N/A” is published instead of that estimate; such estimates for all countries covered by the report are included in the aggregates for geographic, political and economic groups of countries even if not published separately.

In this edition of WMEAT, 11-year mean figures are published for all parameters for all countries, partly because this edition’s country ranking on the basis of 11-year mean figures would bracket them so narrowly that there is little point in masking them. 11-year mean figures are not color-coded. However, the quality 11-year-mean figures depends on the quality of the annual figures of which they are averages. Users of 11-year country mean figures in the “Country Rankings” page of Table I are advised to check the color-coding in the country pages to assess the quality of the figures.

### **Deflators used to generate constant dollar values**

*WMEAT 2012* reverts to the practice of editions before *WMEAT 2005* in using the U.S. GDP deflator to deflate all figures expressed in constant dollar terms. *WMEAT 2005* generated constant-dollar values for total trade (in Table II) using the U.S. consumer price index, and constant-dollar values for arms transfers (in Tables II and IV) using the “non-pay defense sector deflator” in the National Defense Budget Estimates (aka “the Green Book”) published annually by the [Office of the Comptroller](#) of the U.S. Department of Defense. The results – including current-dollar ratios that differ from constant-dollar ratios – seem to include more confusion than the increase in accuracy is worth, given that the rates of price inflation yielded by the various deflators are similar and relatively low.

Prior editions of WMEAT have generated their constant dollar values of military spending and GDP (or GNP) for years prior to the most recent year covered by reflating current dollar values by the U.S. GDP deflator, derived from current and constant dollars time series in [U.S. GDP statistics](#) published by the U.S. Bureau of Economic Analysis (BEA). *WMEAT 2012* uses the constant and current dollar values for U.S. GDP provided by the World Bank’s [WDI database](#), which derive from BEA’s values.<sup>25</sup>

### **Methods of converting military expenditures and GDP to US dollars**

Cross-country comparison of Table I’s economic parameters – military spending and its comparator parameter, GDP – requires expression in a common currency of

<sup>25</sup> The values used for the US GDP deflator are given at the bottom the constant-dollar sections of Tables II.a, II.b, and II.c, and at the bottom of Tables II.d and IV.a.

values originally expressed in diverse national currencies. Consequently, Table I reports values for military expenditures and GDP in U.S. dollar terms for all countries, although source data are expressed in national currency terms. (By contrast, preparation of Tables II, III and IV, the arms transfer tables, involves no currency conversion; WMEAT receives its input data for arms transfers and total trade in current U.S. dollar terms.)

Past editions of WMEAT have converted all military expenditure or GDP figures for any given country using a single currency conversion method. Editions before *WMEAT 2005* converted military spending and GNP (then used instead of GDP) values for some Communist and former-Communist countries at purchasing power parity (PPP), but converted them for most countries at a real exchange rate based on the year-average market exchange rate (MER) observed or estimated for most recent year covered. *WMEAT 2005* converted military spending and GDP for all countries using the latter method.

*WMEAT 2012* innovates presentation of military spending and GDP figures using multiple distinct methods of currency conversion – five of them for countries and geographic groups, three of them for political and economic groups and for rankings. Each method has advantages and disadvantages. The results yielded by some of them differ substantially, both over time and across countries, with respect either to the dollar value of military spending, or to the share of military spending in GDP. The “Overview” page of Table I shows, for both countries and groups of countries, the range of military spending, both in dollar terms and as a share of GDP, yielded by these different conversion methods.

The problem of choosing a conversion method adds to the already large uncertainties poses by data quality problems for many countries. It is hoped that presentation of U.S. dollar values for military spending and GDP obtained by multiple currency conversion methods may both illustrate the magnitude of this uncertainty and help analysts to cope with it.

The remainder of this subsection will describe each of the five currency conversion methods used in this edition of WMEAT to convert foreign-currency-denominated data for military spending and GDP to U.S. dollars; the sources and limitations of data for each, and the advantages and disadvantages of each.

***Method 1:*** *Conversion of both military expenditure and GDP at a real market exchange rate based on the most recent year covered.*

This is the method of currency conversion used by past editions of WMEAT for most countries, and by *WMEAT 2005* for all countries. In this edition of WMEAT, it is used to generate the first of the five formally identical but substantively different sets of “economic values” on the country pages (rows 14 – 24 and 103 – 110) and on the first “Geographic Groups” page of Table I. The headings for dollar values and percentages generated by this method are shown in the left-hand column in **black** typeface.

This method is designed to facilitate “trend” or “time-series” analysis within a single country over a number of years, such as the 11-year period covered by a WMEAT edition.<sup>26</sup> It avoids distortion of such trends by market exchange rate fluctuation due to factors other than “real” changes in relative aggregate price levels between the USA and another country. Insofar as aggregate price changes in the defense sectors of both countries approximate aggregate price changes in their economies as a whole, it does so without distorting trends in the share of GDP to which military spending is equivalent, commonly called “the military burden.”

This method eliminates “non-real” exchange rate fluctuations by using an observed or estimated market exchange rate (MER) for only one year, the base year, which in WMEAT has been the most recent year covered (2009 for *WMEAT 2012*). Market exchange rates for the other ten of the 11 years covered are not used to generate dollar values of military spending or GDP for those years. Instead, the base-year exchange rate is projected onto the other years, discounted by the relative rate of aggregate price inflation for the U.S. and the foreign country, as measured by the ratio of their respective GDP deflators. Because it seeks to eliminate the effects of exchange rate fluctuations that are not due to changes in the relative prices of “real” goods and services, international economic literature calls the non-base-year conversion rates generated by this process “[real exchange rates](#).”<sup>27</sup>

For example, if aggregate price inflation between the base year and a previous year were 5% for the U.S. and 10% for country X, then this method would in effect convert values for the year prior to the base year from country X’s currency into “current dollars” at a rate that values dollars  $100((1.10/1.05) - 1)\%$  less relative to country X’s currency than did the observed exchange rate in the base year.

Apart from the foreign-currency-denominated data values to be converted, this method requires (a) an observed or estimated year-average market exchange rate (MER) for one year, the base year, and (b) GDP deflators for both the USA and the foreign country for all years covered. For most countries, including the USA, time series both of MER’s and of current and constant prices (from which GDP deflators are readily derived) are provided by the World Bank’s [WDI database](#), and are used by *WMEAT 2012*.

These year-average “market exchange rates” obtained from the WDI database generally are the “rf” exchange rate published in the [IMF/IFS](#). Such year-average market exchange rates are used for all countries for which they are available unless another rate

<sup>26</sup> Since its inception in the 1960s, WMEAT has focused on trends in both military expenditures and arms transfers. Since 1994, section 404 of PL 87-297, the Arms Control and Disarmament Act, codified as [22 USC 2593b](#), has required that WMEAT highlight trends in arms transfers.

<sup>27</sup> *Caveat:* In a single-currency context, “real dollars” is widely used as a synonym for “constant dollars,” meaning “inflation-discounted” as opposed to “nominal” or “current” dollars. However, in a multiple-currency context, converting a time series of other-currency-denominated values to dollars at “real exchange rates” does not yield what is commonly meant by “real” or “constant” dollars.



is both legal and generally used, regardless of the extent to which government may repress or manipulate foreign exchange markets.<sup>28</sup> They are frequently not market-clearing or “equilibrium” exchange rates and may also differ greatly from black market rates.

For some countries covered by WMEAT, either “market” exchange rate data or GDP deflator data or both are not available from either the World Bank or the IMF, either because they are not members of those institutions (*e.g.*, Cuba and North Korea) or because, although members, they have not reported economic data for the period covered to those institutions (*e.g.*, Somalia). Exchange rate data for such countries are drawn from other sources, including the [EIU Websites Data Services Alacra](#) of the EIU and the [National Accounts Main Aggregates Database](#) of the U.N Statistics Division. For some countries with an “unofficial” but legal and generally used but not officially reported exchange rate, such as Burma (Myanmar), that rate is used by WMEAT and sourced from diverse websites.

**Method 2:** *Conversion of both military expenditure and GDP a current year-average market exchange rates*

This is the method that one might naively expect to be used: for each year, local currency data values for that year are multiplied by an observed or estimated year-average market exchange rate for the same year. In this edition of WMEAT, this method is used to generate the second of the five formally identical but substantively different sets of “economic values” on the country pages (rows 28 – 37 and 114 – 120) and on the first “Geographic Groups” page of Table I. The headings for dollar values and percentages generated by this method are shown in the left-hand column in **brown** typeface.

This method has the advantage of being easy to understand.

In addition, **Method 2** is likely to be superior to **Method 1** for cross-country comparisons, although inferior to **Method 1** for single-country trend analysis. A real exchange rate scheme for 11 years based on an observed exchange rates for only a single base year (**Method 1**) projects into all 11 years any foreign exchange market anomalies in that one year. For example, if the Japanese yen is unusually dear but the Euro is unusually cheap in the base year, **Method 1** will make Japan’s military spending and GDP anomalously large relative to Germany’s military spending and GDP for all 11 years. Since a large “error” of this sort is less likely to be observed in all 11 years than in a single year, **Method 2** tends to be less prone to error in cross-country comparison than **Method 1**. However, **Method 2** tends to be inferior for single-country trend analysis because it does not exclude the effects of year-to-year exchange rate fluctuations caused by factors other than relative aggregate price changes.

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<sup>28</sup> A summary overview of national exchange rate regimes is provided by the IMF’s [Classification of Exchange Rates and Monetary Arrangements](#).

**Method 3:** *Conversion of both military expenditure and GDP at a real market exchange rate based on the mean of all 11 year-average market exchange rates, assigned to the mid-period (sixth) year.*

In this edition of WMEAT, this method is used to generate the third of the five formally identical but substantively different sets of “economic values” on the country pages (rows 39 – 49 and 122 – 129) and on the first “Geographic Groups” page of Table I. It is also used to generate the first of three formally identical but substantively different sets of economic parameter values on the second “Geographic Groups” page and on the “Political Groups,” “Economic Groups,” “Group Rankings” and “Country Rankings” pages of Table I. The headings for parameter values generated by this method are shown in the left-hand column in **green** typeface.

This method is innovated by WMEAT 2012 in the hope of capturing both the time-series (trend) analysis advantages of **Method 1** and the cross-country analysis advantages of **Method 2**. To our knowledge, it has not been used elsewhere.

Like **Method 1**, **Method 3** converts foreign-currency-denominated values to dollars at “real exchange rates” based on an exchange rate assigned to a single year, and using the ratio of US and foreign GDP deflators to project that rate into the other ten years. **Method 3** thereby eliminates the effects of exchange rate fluctuations not caused by changes in the relative aggregate prices of goods and services in the USA and the foreign country, just as **Method 1** does. However, in **Method 3**, the exchange rate assigned to the base (mid-period, *i.e.*, sixth) year is not a single year’s average market exchange rate; it is the inflation-difference-discounted average market exchange rate for the whole 11-year period. More specifically, it is the arithmetic mean of the 11 year-average market exchange rates, rendered comparable by multiplication of each by the ratio of the foreign to the US GDP deflator for the time period separating the year in which it was observed (or for which it is estimated) from the mid-period year. Unlike **Method 1**, **Method 2** and **Method 3** cannot yield results distorted by a single base year’s deviation from the period-average MER. Hence, **Method 3**, like **Method 2**, is superior to **Method 1** for cross-country analysis – insofar as the evolution of inflation-difference-discounted exchange rates during the period is not distorted by arithmetic averaging.

**Method 3** is as good as **Method 1** for trend (time series) analysis: for any given parameter, for any country or group of countries, the percentage change in value between any two years covered (*e.g.*, from the first year covered to the last year covered) is identical before rounding for both methods. Consequently (for reasons already stated in comparing **Method 1** to **Method 2**), **Method 3** seems likely to be better than **Method 2** for trend analysis.

For the period covered in WMEAT 2012, **Method 3** appears, empirically, for purposes of cross-country analysis, to be better on average than **Method 1** but riskier – better for large groups of countries, but not necessarily for single countries or small

groups of countries. Relative to **Method 1**, **Method 3** appears to yield a distribution of period-mean values closer on average to those yielded by **Method 2** but with “fatter tails.”<sup>29</sup>

**Method 3** fails abjectly in the presence of accelerating hyperinflation in a foreign country (relative to price inflation in the USA). It fails because arithmetic averaging is a linear process, whereas accelerating price inflation is not. This failure is exemplified by the 11-year-mean GDP per capita value of that **Method 3** yields for Zimbabwe in this edition of WMEAT: 22 constant 2009 US dollars, which is more than an order of magnitude too low. However, Zimbabwe, the only country known to have suffered accelerating hyperinflation during the period covered by this edition of WMEAT, seems to be the only country for which this method is dramatically inferior to both **Method 1** and **Method 2** for cross-country analysis.

For a world in which accelerating hyperinflation seems rare, **Method 3** appears better, as a single method to be used for both trend analysis and cross-country analysis purposes, than either **Method 1** or **Method 2**. Consequently:

- **Method 3** is the only “market exchange rate” conversion method used both on the second “Geographic Groups” page, on the “Political Groups” and “Economic Groups” pages, and on the “Group Rankings” and “Country Rankings” pages, as a comparator to PPP conversion methods (**Method 4** and **Method 5**);<sup>30</sup> and

<sup>29</sup> For the world and for every continent except the Americas, the 11-year-mean value for military spending or GDP yielded by **Method 3** is closer to that yielded by **Method 2** than is that yielded by **Method 1**. Moreover, across the 170 countries covered by this edition of WMEAT:

- the period-mean values yielded by **Method 3** are closer to those yielded by **Method 2** than are those yielded by **Method 1** in 88 cases and equally close in 4;
- the average percentage deviation from the period-mean value yielded by **Method 2** is less for **Method 3** (11.9%) than for **Method 1** (15.0%); and
- the standard error from the period-mean value yielded by **Method 2** as a proportion of that value was less for **Method 3** (11.9%) than for **Method 1** (19.0%).

However:

- the range of percentage deviation from the period-mean value yielded by **Method 2** is greater for **Method 3** (-90.2% to 30.0%) than for **Method 1** (-64.2% to 23.4%);
- the standard deviation of percentage deviation of the period-mean results yielded by **Method 3** from those yielded by **Method 2**, is greater, as a proportion of the average of percentage deviation of those results, for **Method 3** (178%) than for **Method 1** (88%).

<sup>30</sup> Use of **Method 3** to generate country rankings based on 11-year-mean MER values may seem questionable for two reasons: (1) 11-year-mean MER values generated by **Method 3** seem likely to be inferior, for cross-country comparison of static values, to those generated by **Method 2**. (2) Relative to 11-year-mean MER values generated by **Method 1**, those generated by **Method 3**, although likely on average to be closer to those generated by **Method 2**, also seem more likely to differ greatly for any single country from those generated by **Method 2**. However: (a) The “Country Rankings” page, already more than 7,500 rows in length including rankings based on only one MER conversion method, would become even more unwieldy if it included rankings based on more than one such method. (b) The rankings both of countries and of groups compare not only static values but also trends across countries, for which combination of purposes **Method 3** seems the best MER conversion method. (c) To use different conversion methods to generate MER-based group rankings and MER-based and country rankings could be confusing, and **Method 3** seems best for generating group rankings at an MER.

- **Method 3** is the “market exchange rate” used, along with the PPP conversion rate for the whole economy, notionally to estimate a PPP conversion rate for the defense sector in **Method 5**.

**Method 4:** *Conversion of both military expenditure and GDP at the purchasing power parity rate for the whole economy (at PPP-for-GDP)*

In this edition of WMEAT, this method is used to generate the fourth of the five formally identical but substantively different sets of “economic values” on the country pages (rows 51 – 60 and 131 – 137) and on the first “Geographic Groups” page of Table I. It is also used to generate the second of three formally identical but substantively different sets of economic parameter values on the second “Geographic Groups” page and on the “Political Groups,” “Economic Groups,” “Group Rankings” and “Country Rankings” pages of Table I. The headings for parameter values generated by this method are shown in the left-hand column in **dark red** typeface.

The US dollar purchasing power parity (PPP) value of a foreign good or service, or set of foreign goods and services, is what that good, service, or set of goods and services costs in the United States. The PPP value of a foreign country’s economy is notionally what all the goods and services produced in that country would be worth if valued at US prices. The US dollar PPP conversion rate for the whole economy of that country, usually referred to simply as the PPP rate for that country, is the market exchange rate (MER) multiplied by the ratio of that country’s GDP at the market exchange rate to its GDP evaluated at US purchasing power parity.

This edition of WMEAT sources U.S. dollar PPP values for GDP and U.S. dollar PPP conversion rates for most foreign countries from the World Bank’s [WDI database](#).

For other countries, including countries that are not members of the World Bank, US dollar values for GDP or PPP conversion rates for GDP are sourced from diverse sources including national statistical agency websites or the [EIU Websites Data Services Alacra](#) of the *Economist Intelligence Unit (EIU)*.

In theory, the extent to which the US dollar PPP value of a foreign country’s GDP differs from its US dollar MER value depends on chiefly on (a) the extent to which its economy consists of “non-tradables,” that is, products and inputs that are not readily tradable internationally, and (b) the extent to which the prices of non-tradables in that country differ from the prices of non-tradables in the U.S. Of these non-tradables, by far the greatest in terms of aggregate value, in most countries, is labor. The proportion by which the US dollar PPP value of a foreign country’s GDP exceeds its US dollar value at the MER tends to increase with the extent to which its labor tends to be less productive and to earn less than labor in the U.S. – that is, insofar as its people are poorer than people in the United States. Conversely, the PPP values of the economies of the few countries that are richer than the U.S. at the MER tend to be less than their MER values.

For a country substantially poorer than the U.S., converting its military spending to U.S. dollars at a market exchange rate tends to understate the value of the output of a country's military spending, *i.e.*, of what it gets for its military spending, relative to that of the U.S. and other comparably rich countries, insofar as the foreign country's defense sector employs internationally non-tradable resources that are priced below U.S. prices – in particular, insofar as its military and its defense industries employ labor at wages lower than U.S. wages. Converting its military spending to U.S. dollars at the PPP rate may correct this understatement. As the page of SIPRI's website titled, "[Measuring Military Expenditure](#)," in its section titled "[Market exchange rates vs purchasing power parity \(PPP\) rates](#)," observes:

Using GDP-based PPP rates instead of MERs for currency conversion results in much higher output and expenditure figures for many developing and transition countries since they have relatively low prices for non-traded goods and services – thus giving the currency higher purchasing power. ... For those such developing and transition countries for whom data was available for 2008, the median increase in military expenditure figures from using PPP rates instead of MERs was around a factor of 2. Three-quarters of these countries would see their relative figures increase by at least two-thirds.

However, to convert a foreign country's military expenditures at the US dollar PPP rate for its GDP yields an accurate indicator of the output of military expenditures only if:

- (a) the country's defense sector employs non-tradables to the same extent as its economy as a whole, and
- (b) the prices of non-tradables in the defense sector differ from their U.S. prices to the same extent as in its economy as a whole, or if
- (c) lower (higher) non-tradables intensity in the defense sector is fortuitously offset by higher (lower) non-tradables prices in the defense sector.

For many countries poorer than the U.S., the defense sector seems likely to be less labor-intensive, and hence less non-tradables intensive, than the economy as a whole. An indicator of this is that, for many such countries, the ratio of military spending per armed forces member to GDP per labor force member (given on row 91 of each country page in this edition of WMEAT) greatly exceeds one. Indeed, the 11-year-mean value for this ratio appears to be highest – greater than seven – for the middle (third) quintile of world population ranked by national GDP per capita, and second-highest for the fourth (second-poorest) quintile of world population ranked by national GDP per capita.<sup>31</sup> That is, the militaries of lower- and middle-income countries seem on average to be far less labor-intensive and more capital-intensive than their economies as a whole. Insofar as capital may tend to be more tradable internationally than labor, and insofar as the capital-intensity of militaries may tend to be correlated positively with the capital-intensity of

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<sup>31</sup> See the "Economic Groups" page of Table I, rows 556 – 570.



defense sectors across countries, this suggests that lower- and middle-income countries generally may have defense sectors markedly more capital-intensive than their economies as a whole.

For such a country, to convert military spending to U.S. dollars at the PPP rate for the whole economy, *i.e.*, at the PPP rate for GDP, may overstate the value of the output of the country's military spending relative not only to the military spending of the U.S. and other rich countries, but also to that country's GDP.

For any single country, its "military burden," that is, the share of its GDP to which its military expenditure is equivalent, is unaffected by the choice of method used to convert military spending and GDP to dollars, provided that both are converted at the same rate – as they are by **Method 1**, **Method 2**, **Method 3** and **Method 4**. For groups of countries, the military burden vary, but appears to vary only slightly, among such methods. Consequently, if **Method 4** may tend to overstate the military burden of lower- and middle-income countries, then so, to roughly the same extent and for the same reason, may any other method that converts both military expenditure and GDP to dollars at the same rate, including **Method 1**, **Method 2** and **Method 3**. None of these methods makes allowance for the likelihood that the defense sectors of lower- and middle-income countries generally may be substantially less non-tradables intensive than their economies as a whole, as seems to be suggested by the observation that their militaries generally appear to be far less labor-intensive than their economies as a whole. The domestic purchasing power and the domestic opportunity cost of resources employed in their defense sectors generally may be less, relative to that of resources employed in their economies as a whole, than is indicated by the military burden ratio generated by any currency conversion method that converts both military expenditure and GDP to dollars at the same rate.

***Method 5:** Conversion of military expenditure at a notionally estimated defense-sector-specific PPP rate, and of GDP at the PPP rate for the whole economy*

For such reasons, the best indicator of the product of a country's military spending, relative not only to the products of the military expenditures of other countries but also to its own GDP, would be obtained by converting defense expenditures to dollars at a defense-sector-specific PPP rate, distinct from the PPP rate for the whole economy at which GDP should be converted to dollars to obtain the best indicator of a country's output relative to the outputs of other countries.

This has been widely recognized since before 13 December 1982, when the U.N. General Assembly (UNGA) asked the Secretary General to enlist qualified experts from member states to construct price indexes and purchasing power parities for military expenditures of voluntarily participating states. In response, a U.N. Group of Experts on the Reduction of Military Budgets submitted to the Secretary General, on 13 August 1985, an 81-page report, "[Construction of military price indexes and purchasing power](#)

[parities for comparison of military expenditures](#)” (U.N. Document A/40/421), describing the data needed rigorously to construct defense-sector-specific PPP rates. On 1 November 1985, the chairman of the group, Hans Christian Cars of Sweden, reported to a [meeting](#) of the UNGA First Committee that Australia, Austria, Finland, Italy, Norway, Sweden, the United Kingdom and the United States had participated in the effort to construct defense-sector-specific PPP rates for their countries using the methodology prescribed by the U.N. Group of Experts. He reported the following results of the group’s exercise:

Information on items which fall within the procurement category, that is, weapons, weapons systems, and other military equipment ... turned out to be much less available. The limited amount of data on military hardware presented a major problem for the group. ... Another major problem that the group faced was the comparison of conscripted and enlisted soldiers ... Military purchasing power parities have been constructed for all participating states ... However, to achieve those results, the Group had to use a limited number of surrogate indexes and parities ...

Thirty years after the U.N. General Assembly’s 1982 request, no rigorous estimate of a defense-sector-specific PPP rate is known to have been produced for even one country for even one year. The data required to construct one rigorously appear not to be available, even for countries with relatively transparent military expenditures.

However, to convert military expenditures to dollars at notionally estimated country defense-sector PPP rates, constructed using data readily available for nearly all countries, might, despite lack of rigor, be better than converting both military expenditures and GDP to dollars *exclusively* at the same rate. **Method 5** attempts to do this, based on assumptions that are, admittedly, heroically strenuous. This method is offered, not as a stand-alone “best method,” but as a method that may “add value” when used *in conjunction with other methods* of converting military expenditure and GDP to dollars. The idea is to do what we can with the data available, in the hope of offering some notion of how much:

- converting both military expenditure and GDP to dollars at an MER understates the value of the military expenditures of lower- and middle-income countries relative to those of upper-income countries including the United States;
- converting both military expenditures and GDP to dollars at PPP-for-GDP overstates the military expenditures of lower- and middle-income countries relative to those of upper-income countries including the United States; and
- converting both military expenditures and GDP to dollars at the same rate, regardless of the rate used, overstates the military burdens of lower- and middle-income countries relative to those of upper-income countries including the U.S.

Insofar as degree of political democracy may be correlated with GDP per capita,<sup>32</sup> “less democratic” may be substituted for “lower- and middle-income” and “more democratic” might be substituted for “upper-income” in the previous sentence.

<sup>32</sup> See the “Political Groups” page of Table I, rows 334 – 367.

The intuition underlying **Method 5** is the following. Assuming that the prices of non-tradables are the same across all sectors of a country's economy, then:

- For a country with a defense sector that is far less non-tradables-intensive than its economy generally, the dollar value of military spending at defense-sector-specific PPP will be closer to the dollar value of military spending at the MER than to the dollar value of military spending at PPP-for-GDP.
- For a country with a defense sector that is only slightly less non-tradables-intensive than its economy generally, the dollar value of military spending at defense-sector-specific PPP will be closer to the dollar value of military spending at PPP-for-GDP than to the dollar value of military spending at the MER.

To operationalize this intuition with data that are readily available for nearly all countries:

- We use the capital-intensivity of the military (as measured by military spending per armed forces member) as a surrogate for the tradables-intensivity of the defense sector; and
- We use the capital-intensivity of the whole economy (as measured by GDP per labor force member) as a surrogate for the tradables-intensivity of the whole economy.

The assumptions of this approach seem justifiable given the data constraints. Although labor tends to be the largest non-tradable in most economies, capital is not perfectly tradable internationally, labor is not utterly non-tradable, either as factor or as embodied in goods, and labor is not the only non-tradable in an economy. Furthermore, although the capital-intensivity of the defense sector including defense industries seems likely to be correlated with the capital-intensivity of the military, a correlation is not an identity. Nevertheless, setting these problems aside, we can restate our intuition in terms that can be operationalized with available data as follows:

- For a country with a defense sector that is far less labor-intensive (far more capital-intensive) than its economy generally, the dollar value of military spending at defense-sector-specific PPP will be closer to the dollar value of military spending at the MER than to the dollar value of military spending at PPP-for-GDP.
- For a country with a defense sector that is only slightly less labor-intensive (only slightly more capital-intensive) than its economy generally, the dollar value of military spending at defense-sector-specific PPP will be closer to the dollar value of military spending at PPP-for-GDP than to the dollar value of military spending at the MER.

In algebraic terms, **Method 5** involves estimating a country's defense-sector-specific PPP as follows:

$$S_s = \text{MIN}(S_p, (S_m + (K_e / K_d)(S_p - S_m))) \text{ IFF } S_p > S_m$$

(case typical of countries poorer than the USA)

OR

$$\text{MAX} (S_p, (S_m - (K_e / K_d)(S_m - S_p))) \text{ IFF } S_p \leq S_m$$

(case typical of countries richer than the USA)

where:

$S_s$  is the dollar value of military spending at a PPP rate for the defense sector. This is what is to be estimated.

$S_p$  is the dollar value of military expenditure at the PPP rate for the whole economy (PPP for GDP).

$S_m$  is the dollar value of military expenditure at the real MER generated by **Method 3**.<sup>33</sup>

$K_d$  is an indicator of the capital-intensivity of the defense sector, specifically military spending per armed forces member in local currency terms. This serves as a proxy for the tradables-intensivity of the defense sector.

$K_e$  is an indicator of the capital-intensivity of the whole economy, specifically GDP per labor force member in local currency terms. This serves as a proxy for the tradables-intensivity of the whole economy.

Basically, this approach uses the ratio of military spending per armed forces member to GDP per labor force member to assign the defense-sector dollar PPP value of military spending to a point on the interval between the dollar value of military spending at the MER and the dollar value of military spending at the PPP rate for the whole economy.

This approach to estimating  $S_s$ , sets limits to keep the result within the range between  $S_m$  and  $S_p$ , specifically by setting the capital-intensivity of the whole economy as a lower limit to the capital-intensivity of the defense sector. The intuitive justification for these limits is that a military seems unlikely to be less capital-intensive than its country's economy as a whole, except in countries for which a patron state handles external defense and democratic legitimacy obviates the use of force for internal security. These limits are binding for about 20 countries for which military spending per armed forces member appears to be less than GDP per member of the labor force, on an 11-year-mean basis (per rows 3466 – 3635 of the “Country Rankings” page of Table I). However, this may indicate underestimation of military expenditure in local currency terms for many of these countries.

<sup>33</sup> Any method of converting military expenditure to dollars at a market exchange rate could plausibly be used, e.g., either **Method 1**, **Method 2** or **Method 3**. **Method 3** is used because it seems better than either Method 1 or Method 2 as a single rate to be used both for trend analysis and for cross-country analysis, and the defense-sector-specific PPP value for military expenditure to be estimated is intended for use both for trend analysis and for cross-country analysis.

The specific functional form of this approach to estimating the defense-sector-specific dollar PPP value of military spending allows this to equal (but not to be further from the MER than) the value of military spending at PPP-for-GDP, but allows it only to approach asymptotically the MER value of military spending. The hyperbolic nature of a ratio, in this case,  $K_e / K_d$ , the ratio of GDP per labor force member to military spending per armed forces member, implies that the ratio must be exogenously limited on one but not both extremes to yield a finite range of values.

The above-specified form of **Method 5** is the best approach to estimating the value of military spending at a defense-sector-specific GDP that the preparers of WMEAT have been able to think of. However, it is not necessarily the best approach that can be devised using data readily available for nearly all countries. Readers' suggestions for improving **Method 5** in ways that require only data readily available for nearly all countries are sincerely solicited, and may be sent to [WMEATEditor@state.gov](mailto:WMEATEditor@state.gov).

In this edition of WMEAT, **Method 5** is used to generate the fifth of the five formally identical but substantively different sets of economic parameter values on the country pages (rows 62 – 72 and 139 – 146) and on the first “Geographic Groups” page of Table I. It is also used to generate the third of three formally identical but substantively different sets of economic parameter values on the second “Geographic Groups” page and on the “Political Groups,” “Economic Groups,” “Group Rankings” and “Country Rankings” pages of Table I. The headings for parameter values generated by this method are shown in the left-hand column in **purple** typeface.